PATENT SPECIFICATION

DRAWINGS ATTACHED

1,059,793

1,059,793

Date of Application and filing Complete Specification: Aug. 20, 1964.
No. 34150/64.
Application made in France (No. 946579) on Sept. 4, 1963.
Complete Specification Published: Feb. 22, 1967.

Index at acceptance:—H2 A(1C3F, 1C3M, 5X, 8A, 8G, 8X, 9B, 11A, 19)

Int. Cl.:—H 02 k 3/26

COMPLETE SPECIFICATION

Improvements in D.C. Dynamo-electric Machines

We, SOCIETE D'ELECTRONIQUE ET D'AUTOMATISME, of 17—19 rue Moulin des Bruyeres, Courbevoie, France, a French body corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improvements in direct current dynamo-electric machines operating from a source of low voltage, and taking a high electrical current the value of which may reach several hundreds of amperes.

According to the present invention there is provided a D.C. dynamo-electric machine comprising in combination a stator including a permanent magnet field structure consisting of equi-spaced magnet poles of alternate polarity; a rotor arranged to form a magnetic air-gap with said stator, the rotor comprising a plurality of conductor blades arranged in at least one layer with their longitudinal axes orientated substantially along the greater rectilinear dimension of the air-gap, said blades being at least partly bare on one of their faces near at least one end thereof, at least one pair of brushes making contact with the bare end faces of those conductor blades and situated immediately adjacent the axes of a pair of stator poles, said pair of brushes being electrically connected to a pair of terminals, and means for electrically connecting together the other ends of said conductor blades to complete an electrical circuit between the pair of terminals via only those conductor blades in direct contact with the brushes.

In the case where the machine is of the flat annular airgap type, the electrical connecting means between the conductor blades may comprise a conductive ring which is integral with either the inner or outer periphery of the conductor blades.

The invention is also applicable to dynamo-electric machines of the cylindrical air-gap type.

The present invention will now be described in further detail by way of examples with reference to the accompanying drawings, wherein:—

Figure 1 is a view of one face of a rotor of a first embodiment of a dynamo-electric machine of the flat annular air-gap type;

Figure 2 is an elevation cross-sectional view of the dynamo-electric machine;

Figures 3 and 4 show a modified embodiment, the views being similar to those of Figures 1 and 2, except that only the upper half of the dynamo-electric machine is shown;

Figure 5 is a view of one face of the rotor of a second embodiment of a dynamo-electric machine of the flat annular air-gap type;

Figure 6 is an elevation cross-sectional view of the dynamo-electric machine;

Figures 7 and 8 show linear developed views of the arrangements of the brushes and rotors of the embodiments shown in Figures 1—2 and in Figures 5—6 respectively;

Figure 9 shows a partial cross-sectional elevation view of a dynamo-electric machine comprising several layers of conductor blades in order to increase the power of the machine; and

Figure 10 shows a partial top view of the rotor of the machine illustrated in Figure 9.

Referring to Figures 1 and 2, the stator of the dynamo-electric machine comprises a ring of equi-spaced permanent magnets 6 arranged alternately North and South, (N and S). The number of poles is comparatively high. In the embodiment illustrated, eight are shown, but it is frequently desirable to use a higher number of poles. On the other hand the magnetic angular coverage of each pole piece is advantageously reduced to

approximately 60 electrical degrees. This results in an appreciable economy in the use of magnetic material in the machine. In an alternative embodiment instead of the poles being separate, they may be replaced by a single annular magnetic ring of ferrite into which magnetic poles have been permanently induced.

A magnetic plate 15 which acts as a return path for the magnetic flux, co-operates with the ring of magnets 6 to define a short magnetic air-gap. Such a plate may be replaced, when required, by a ring of magnets similar to magnets 6 having a shift of one pole pitch from one ring to the other. The plate 15 is secured to a yoke plate 13 carrying the magnets 6, by struts 16.

A discoidal rotor 1 is mounted at one end of a shaft 9, and is held against a hub 10, by a washer 11 and a nut 12. The shaft 9 runs in bearings 14 mounted on the yoke plate 13. The discoidal rotor 1 is made from a conductive member in which radial slots 2 define between them a plurality of radial blades 3 which are short-circuited at their outer ends by a conductive ring 4 which is left unslotted. The outer edge of the ring 4 may be bent over as shown at 5 in Figure 2 in order to strengthen the rotor.

Centered on each axis of a magnet 6 is a brush 7, which is carried by the magnetic plate 15 at a location which is near to the inner ends of the conductor blades 3 of the rotor 1. The brushes 7 which are located on the axes of the South poles are connected together to one electrical terminal of a pair of terminals 8 and the brushes which are located on the axes of the North poles are connected together to the other terminal of the pair of terminals 8. The terminals either carry direct current to the machine or from the machine according to whether the machine operates as a motor or a generator. Each brush 7 ensures the short-circuiting of at least two consecutive conductor blades 3 during the rotation of the rotor 1.

Instead of short-circuiting the blades 3 by their outer ends, the blades may be short-circuited by their inner ends by means of an integral inner ring 44 as shown in Figures 3 and 4. In this case the brushes 17 are arranged near the outer edge of the rotor disc. Instead of bending over the outer edge of the rotor, an annulus 5 of insulating material may be provided and glued to the outer edge of the rotor disc. Alternatively, the annulus 5 may be made of conductive material if the film of glue applied is in itself sufficiently insulating.

In any case it must be understood that the securing of the discoidal rotor 1 on the hub 10 is made so that the conductor blades are insulated from each other along their lengths.

In a second embodiment illustrated in Figures 5 and 6 the conductor blades 3 (are totally cut off along their length, the slots 2 running from the inner to the outer edge of the rotor disc 1. The separate blades 3 are mechanically united at their inner ends by means of the hub 10 and at their outer ends by means of the insulated annulus 5 which is glued thereto. In a modification of this arrangement (Figure 9), the conductor blades are secured by glueing to a thin insulating carrier disc. "Glue" is intended to cover any kind of strong adhesive such as thermosetting or polymerisable resin. Such a thin carrier disc may be used, if desired, in the embodiments illustrated in Figures 1 to 4, in which case the strengthening annulus 5 is omitted.

Reverting to the embodiment illustrated in Figures 5 and 6, in which the conductor blades are mechanically and electrically separated, each pole axis is provided with a pair of brushes, one brush near the inner end and the other near the outer end of the axis. These brushes are referred to as 7 and 17 and the brushes are connected to form a series circuit between the terminals 8.

The linear developed views of the rotor shown in Figures 7 and 8 give a clearer illustration of the possibilities of interconnection between the brushes. These figures respectively relate to the embodiments of Figures 1—2 and Figures 5—6, and may further be considered, too, as linear developments of cylindrical rotors since the invention can equally well be reduced to practice in cylindrical air-gap machines as in machines having a flat annular air-gap. In cylindrical machines, the blades 3 extend along generants of a cylinder, and the brushes bear on the ends of the blades. The cylinder is supported by end disc-shaped plates, for mounting the rotor on a shaft. The field magnets are arranged to surround the rotor cylinder and a return magnetic flux cylinder is mounted within the rotor cylinder, and is secured to the shaft.

In the case where the machine has a flat annular air-gap, the magnetic return plate 15 can be made a part of the rotor assembly. In this modification the conductor blades 3 are glued on it, and the brushes are placed either on the same side as the magnets or on the side of the plate 15 which has an outer and/or inner diameter leaving bare annuli for the application of the brushes to the ends of the blades.

The conductor blades 3 are obtained either from a mechanical cutting process or from a chemical engraving or etching process applied to a metal foil such as copper or other suitable conducting material. When obtained from an etching process according to any one of the well known printed circuit techniques, the conductor foil is first stuck to a very thin insulating sheet and the

sheet is then either removed after the etching process or is preserved in the final arrangement of the machine. It is well known that conductors formed by a printed circuit technique can withstand large overloads of current.

Such a printed circuit technique is of special advantage when, as shown in Figures 9 and 10, the machine comprises a rotor having several layers of conductor blades. In the example shown there are two layers 1 and 21 which are relatively insulated from each other by a thin insulating film 28. The conductor layer 1 is formed over a thin insulating carrier disc 18. The outer short-circuiting rings 4 and 24 of the blades 3 and 23 are co-axial, and the conductors of the layer 21 are made shorter than those of the layer 1 to enable the bushes 7 and 27 to bear on the blades 3 and 23 of respective layers. The brushes 7 and 27 of the two sets are connected in between respective pairs of terminals (not shown). This arrangement will provide two independent windings where the machine is to be used as a generator or if preferred the two windings may be connected in series by connecting the pairs of terminals in series. An insulating sleeve 19 is provided between the shaft 9 and the hub 10. More than two layers of conductor blades may be provided in a rotor and it is not essential that the short-circuiting rings, when provided, be situated on the same edge in each layer.

The operation of a dynamo-electric machine having two or more layers of conductor blades can be easily understood by considering that for any layer of conductor blades, only those blades are active at any one time which are connected to form closed circuits by the brushes. A local circulation of current between the ends of short-circuited conductors is substantially negligible since the electro-motive forces are approximately the same in adjacent conductor blades. The currents are reversed from pole to pole in the conductor blades so that they add together and determine the polarities on the terminals of the machine when used as a generator, or the dirrection of rotation, when used as a motor. The greater the induction along the pole axes, the more the efficiency will be increased. Hence the advantage of concentrating the magnetic flux within restricted areas on the sides of such axes. When using separate magnets, one may even advantageously use soft iron pieces shaped for concentrating the magnetic flux from the magnets on such reduced areas.

In all the embodiments and modifications thereof described above, the conductor blades have been arranged radially with respect to the flat annular air-gap motor, or the longitudinal axes of the conductor blades are orientated in the same direction as the greater rectilinear dimension of the magnetic air-gap. Of course, it is not essential that the blades be exactly arranged as shown, and therefore they may be slightly inclined or curved with respect to the radial axes in the case of a machine of the flat annular air-gap type.

WHAT WE CLAIM IS:—

1. A D.C. dynamo-electric machine comprising in combination a stator including a permanent magnet field structure consisting of equi-spaced magnet poles of alternate polarity; a rotor arranged to form a magnetic air-gap with said stator, the rotor comprising a plurality of conductor blades arranged in at least one layer with their longitudinal axes orientated substantially along the greater rectilinear dimension of the air-gap, said blades being at least partly bare on one of their faces near at least one end thereof, at least one pair of brushes making contact with the bare end faces of those conductor blades and situated immediately adjacent the axes of a pair of stator poles, said pair of brushes being electrically connected to a pair of terminals, and means for electrically connecting together the other ends of said conductor blades to complete an electrical circuit between the pair of terminals via only those conductor blades in direct contact with the brushes.

2. A D.C. machine according to claim 1, wherein the machine is of the flat annular air-gap type.

3. A D.C. machine according to Claim 2, wherein said electrical connecting means between the conductor blades comprises a conductive ring which is integral with the outer periphery of the conductor blades.

4. A D.C. machine according to Claim 2, wherein said electrical connecting means between the conductor blades comprises a conductive ring which is integral with the inner periphery of the conductor blades.

5. A D.C. machine according to Claim 2, wherein said electrical connecting means between the conductor blades comprises a second pair or electrically interconnected brushes.

6. A D.C. machine according to Claim 3, wherein the outer edge of the rotor is bent over in order to strengthen the rotor.

7. A D.C. machine according to claim 4, wherein an annulus made of an insulating material is glued to the outer edge of the blades in order to strengthen the rotor.

8. A D.C. machine according to Claim 2 wherein the conductor blades are glued over a thin insulating carrier disc.

9. A D.C. machine according to any one of the preceding claims, wherein the field structure comprises magnet poles the number of which is relatively high whereas the span of each of the pole area is relatively small, approximately 60 electrical degrees.

10. A D.C. machine according to any one of the preceding claims wherein the permanent magnet field structure consists of a ferrite ring in which the magnetic poles have been permanently induced.

11. A D.C. machine according to claim 1, wherein the rotor includes more than one layer of conductor blades, said layers being separated by thin insulating films and wherein the lengths of the blades along the greater rectilinear dimension of the air-gap are different from one layer to the next so as to leave uninsulated in each layer at least one zone against which brushes bear.

12. A D.C. machine according to claim 11, wherein the two or more layers of conductor blades are independently connected to two or more pairs of terminals via brushes to provide two or more separate sources of D.C. in the case where the machine operates as a generator.

13. A D.C. machine according to claim 11, wherein the brushes associated with the two or more layers of conductors are connected in series to form a single winding.

14. A D.C. machine according to Claim 3 and any one of the preceding claims 11—13 wherein the machine is of the flat annular air-gap type and the connecting rings in each layer are arranged in co-axial registering relation at the outer periphery of the rotor, the brushes bearing against bare annular rings of conductor blades in each layer, and adjacent to the inner periphery thereof.

15. A D.C. dynamo-electric machine constructed and arranged to operate substantially as herein described with reference to and as illustrated in Figures 1 and 2, or Figures 3 and 4, or Figures 5 and 6, or Figures 9 and 10 of the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1967.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

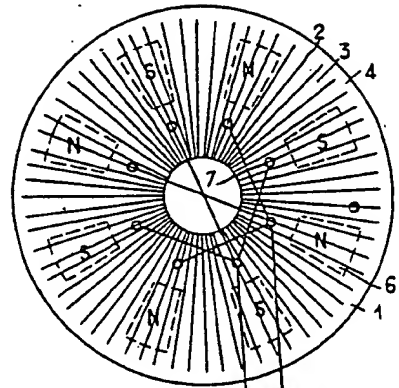


FIG. 1

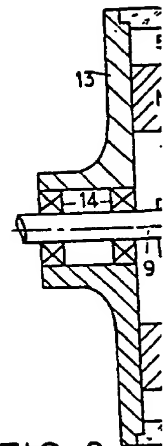


FIG. 2

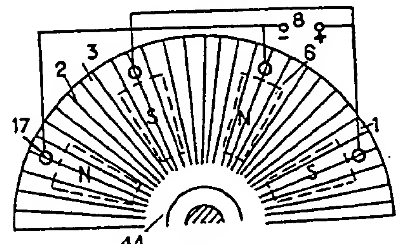
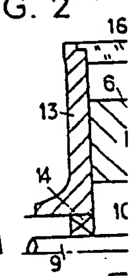


FIG. 3



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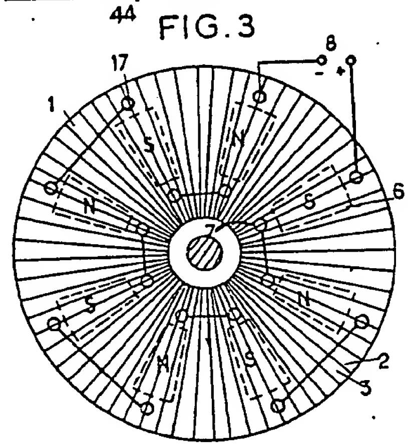
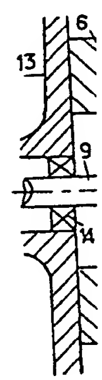


FIG. 5



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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

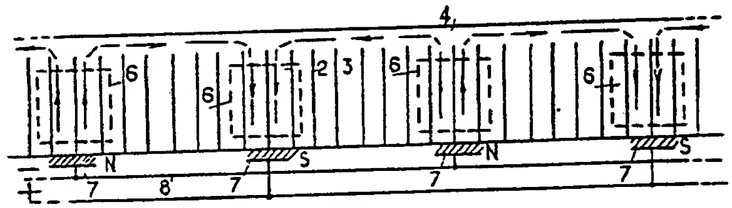

FIG. 7

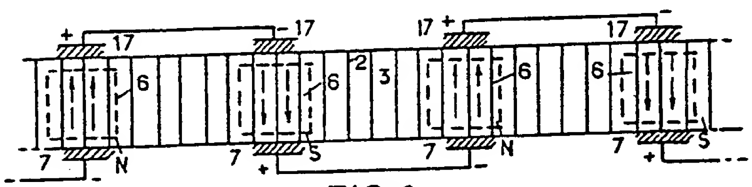

FIG. 8

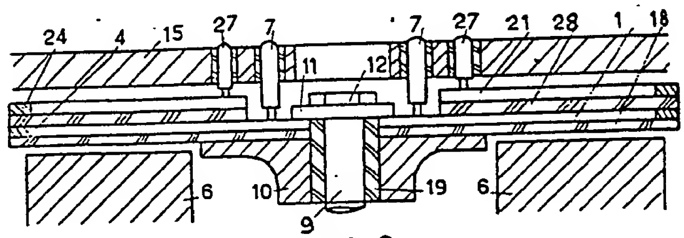

FIG. 9

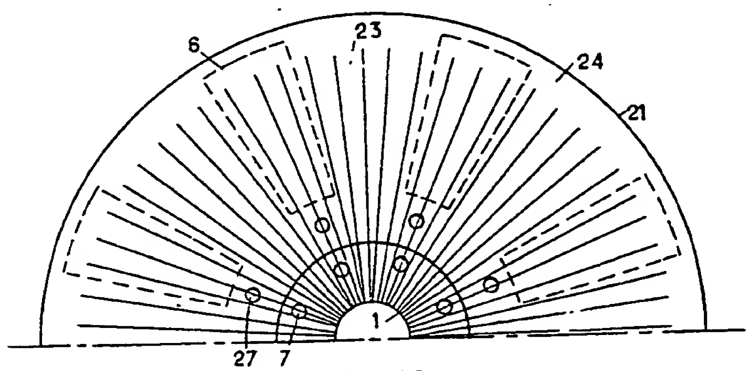

FIG. 10

1059793 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

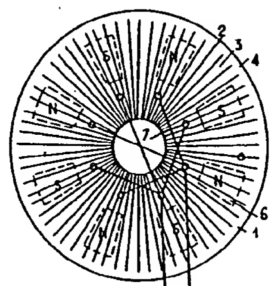

FIG. 1

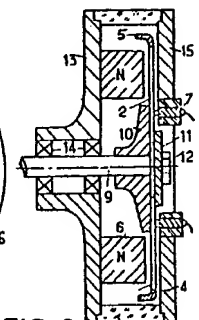

FIG. 2

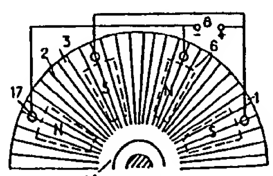

FIG. 3

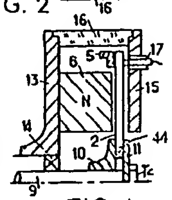

FIG. 4

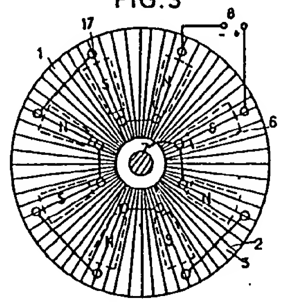

FIG. 5

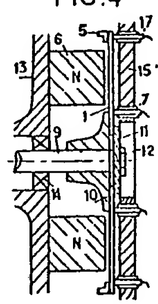

FIG. 6

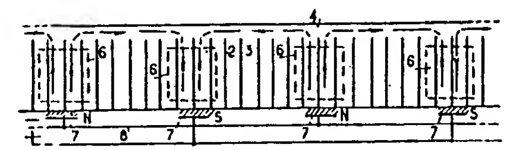

FIG. 7

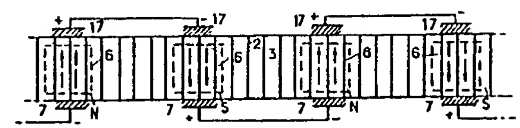

FIG. 8

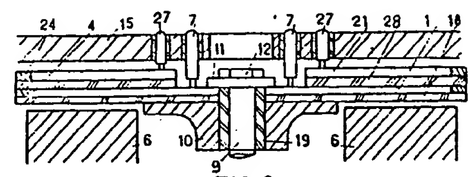

FIG. 9

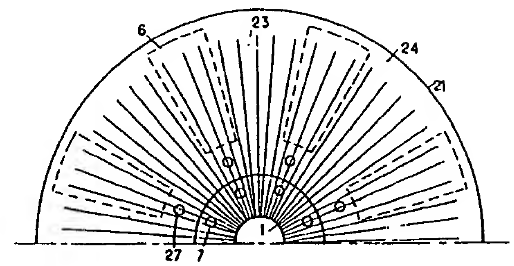

FIG. 10